Reproducible site-specific force spectroscopy at room temperature

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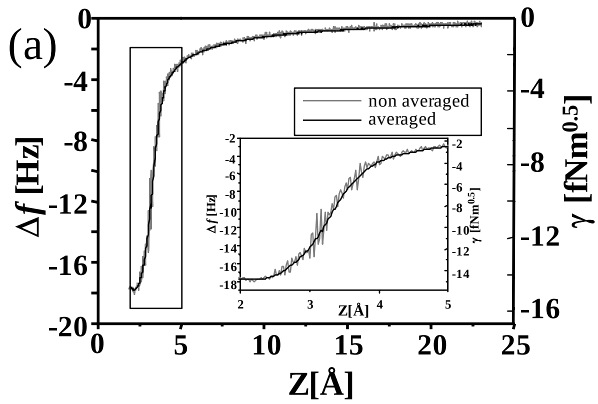
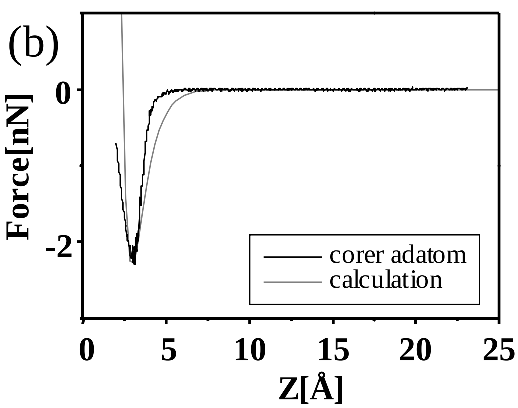
We present site-specific force spectroscopic measurements using the non-contact atomic force microscopy (NC-AFM) at room temperature (RT). The atom-tracking technique [1], in which two feedbacks in the orthogonal lateral scan directions allow positioning the AFM tip over a surface atom within an error better than 0.2Å, can be used for compensating the thermal drift. We have measured series of frequency shift versus distance (Δf-z) curves while tracking a corner adatom of the Si(111)-(7x7) surface at RT. A total of eighty Δf-z curves were obtained in ten times; each time, a group of four forward and backward curves were acquired. Each of these groups was measured in different short-time intervals in which the atom-tracking feedback was momentarily opened. With this method, all of the acquired curves overlapped perfectly. This allows averaging them and, therefore, reducing the noise of the curve as shown in Fig. (a) (black solid line); compared with a non-averaged Δf-z curve (grey solid line), the noise has been improved by more than 10 times (see inset in Fig. (a)). We have extracted the short-range interaction force (black solid line in Fig. (b)) from the averaged Δf-z curve using the inversion algorithm proposed by Sader et al. [2] and an appropriate subtraction of the long-range contribution; it compares very well with the theoretical force distance curve obtained from the Morse potential parameters [3] (grey solid line in Fig. (b)). Additionally, the features of the experimental force curve are similar to those of the one previously reported at cryogenic temperature environment [4], in which the thermal drift is negligible. We will show other spectroscopic measurements in which the acquisition using the atom-tracking technique has proven to be of fundamental importance, allowing an appropriate comparison of the data measured at room temperature on chemically different atom species at the same surface. This method would be also applied to atom manipulation at room temperature in which a precise positioning of the AFM tip is very desirable [5].





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